The French Digital Kitchen:
Implementing Task-Based Language Teaching Beyond the Classroom

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ABSTRACT

This paper reports on the French Digital Kitchen, a design-based project which drew on digital sensor technology to take the principles of Task-Based Language Teaching (TBLT) out of the classroom and into the real-world environment of a kitchen. The project aimed to produce a situated language learning environment where learners could learn aspects of French language and cuisine whilst performing a real-world task. The article describes the blend of TBLT, human-computer interaction (HCI) and user-centred design (UCD) principles the authors adopted in constructing and trialling the kitchen, using multiple data sources. An example of a task cycle is then presented to illustrate (by using CA analysis of transcripts) how learners have used the resources of the kitchen to accomplish the task. The authors' findings show how the integration of the pedagogical and technological design enabled learners to notice and manipulate new vocabulary items.

Keywords: *Digital Kitchen, Digital Sensor, French Language, Human-Computer Interaction (HCI), Task-Based Language Teaching (TBLT), User-Centred Design (UCD)*

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INTRODUCTION

A significant challenge for the UK is how to employ digital technology to upgrade the skills of its workforce in a rapidly changing world. A specific challenge is how to improve the declining foreign language proficiency of the British workforce. The number of pupils gaining a qualification in a foreign language has decreased significantly, whilst a recent British Academy report discussed concerns that the future of the UK's world-class research base might be threatened by the decline in foreign language learning. At the same time, the European Union has acknowledged that Europe faces specific challenges regarding increasing foreign language proficiency, an area which impacts the EU economy in areas such as social mobility between member states and the integration of migrants.

This article reports on the French Digital Kitchen, a French language learning project developed by human-computer interaction technologists and applied linguistics researchers at Newcastle University. Our project involved taking a normal kitchen and specifically adapting it for French language learning using the next generation of digital technology, namely activity recognition and sensor technology. We constructed a purpose-built kitchen that communicates with learners in French and gives them step-by-step instructions on how to prepare French cuisine and teaches aspects of French language.

There are a number of well-known problems relating to classroom foreign language teaching addressed by this project. These include, firstly, the universal problem of classroom language teaching, namely that students are rehearsing using the language, rather than actually using the language to carry out actions such as buying a train ticket; secondly, the difficulty of bringing the foreign culture to life in the classroom. In the digital kitchen environment, we intend that learners will be able to learn aspects of the language whilst performing a meaningful real-world task and will simultaneously experience the cultural aspect of learning to cook a foreign dish.

Our main focus is on how the situated nature of language instruction (timeliness and in context of the tasks) can be supported by technology. In broader terms, the project explores how technology can be used to perform real-world, culturally engaging tasks via the medium of a foreign language and also provides an example of how two rather different sets of skills may be acquired at the same time by use of appropriate technology.

The project involved a range of theoretical and practical issues in relation to language learning and human-computer interaction; the main issue on which this article focuses is how digital technology can be used to deliver task-based language learning in a real-world setting outside the classroom. The article firstly reviews the principles of TBLT and explains how the kitchen works. Next, we introduce the design principles on which the French digital kitchen was based, both in technological and pedagogical terms. After outlining the methodological framework, the study then uses observational data to illustrate how learners have used the kitchen within the 3-stage task cycle, presents the findings of the study and considers future directions for the project.

BACKGROUND: TASK-BASED LANGUAGE TEACHING

The pedagogical design of the French Digital Kitchen employs Task-Based Language Teaching (TBLT), a well-established approach to language learning which prompts learners to achieve a goal or complete a task (Skehan, 1998; 2003). Much like real-world tasks, such as asking for directions, TBLT seeks to develop students' language through providing a task and then using language to solve it. Some of the main features of TBLT are that: meaning is primary (language use rather than form); there is some

communication problem to solve; a classroom task relates directly to real world activities; the assessment is done in terms of outcomes (Ellis, 2003). Willis (1996, p. 1) defines the aims of tasks as "to create a real purpose for language use and to provide a natural context for language study". It is generally assumed (Ellis, 2003, p. 263) that tasks are carried out in pairs or small groups in order to maximise interaction and autonomy. There has been a substantial programme of research in relation to TBLT, summarised in Skehan (2003). Ellis (2003, p. 320) suggests that "there is a clear psycholinguistic rationale (and substantial empirical support) for choosing 'task' as the basis for language pedagogy." Skehan (1998, p. 95) suggests that transacting tasks "…will engage naturalistic acquisitional mechanisms, cause the underlying interlanguage to be stretched, and drive development forward".

TBLT has so far predominantly been based on tasks to be undertaken within the classroom which simulate real-world tasks. Some innovations in TBLT have combined language learning with other, non-linguistic skills in a similar way to this project. Paterson & Willis's (2008) *English through Music*, for example, aims to help children to absorb English naturally as they enjoy making music together. There have been few attempts to employ TBLT in naturalistic settings outside the classroom; the project described here is innovative in combining TBLT and digital technology in a naturalistic kitchen setting outside the classroom.

There are several different conceptualisations of TBLT. We adopted Skehan's (1998) framework in which tasks are divided into 3 phases: *pre-task*, *during-task* and *post-task*. This provided a clear design structure for materials. The *pre-task* functions as a preparation stage for the activity to be carried out in the during-task phase. This may include the presentation of new language, the mobilisation of existing language knowledge and clarification of the type of knowledge that would be required (Skehan, 1998, p. 138). The *during-task* phase involves the performance of the task set. It is in this phase of the task that Skehan claimed learners' attention can be specifically manipulated through a range of features such as time pressure, support and surprise. Skehan also includes reference here to extended task procedures where *during-task* phases are designed to foster attention through scaffolding, where no specific input is given in the *pre-task* and what becomes the focus of learners' attention is based on their needs in the *during-task* (Samuda et al., 1996). The *post-task* phase is designed to manipulate attention through the analysis of *during-task* performance and reflection, as a period of evaluation and consolidation after the completion of the task. This is similar to the 'plenary' section of a school lesson where a teacher goes through the learning objectives of a lesson and pupils identify 'what they have learned'.

Computer-assisted language learning (CALL) has passed through many stages of development since the 1960s as summarised in Davies (2009). Research on TBLT and CALL has been "rather limited" (Motteram & Thomas, 2010, p. 218). Studies have been undertaken into reading tasks (Ros, Sole & Mardomingo, 2004), to using TBLT principles to design an Internet-based activity (González-Lloret, 2003), and to applying a TBLT approach to computer-mediated communication (Smith, 2009; Müller-Hartmann et al., 2010). Recent and popular examples of task types are network-based activities involving learners being immersed in a computer mediated world to complete a 'mission' to find an important document in a 3D world (González-Lloret, 2003), or completing comprehension tasks in a Virtual Learning Environment using blended learning methods (Tsai et al., 2011). Working within a further education context, Tsai et al. (2011) found that students studying for professional qualifications using a mix of web-based self-directed learning methods achieved higher grades than those classmates who had only attended face to face courses. Thomas and Reinders' (2010) collection explores the synergies between TBLT and CALL, exploring TBLT in network-based CALL, CMC, virtual learning environments, intelligent CALL and telecollaboration.

Like the studies of network-based activities or virtual learning contexts mentioned above, the French Digital Kitchen project seeks to explore how TBLT principles can be employed to facilitate language learning outside traditional classroom contexts. The focus in this project is on how TBLT principles can be combined with IT design principles to promote simultaneous learning of two different skills in a naturalistic, real-world setting. The project attempts to realise some of the advantages of TBLT using digital technology in a real-world setting outside the classroom. The kitchen as a setting provides a tangible connection to what Skehan referred to as "real-world activities" (1998, p. 95), where authentic language is used for a communicative purpose and a real-world outcome in terms of a French dish which is eaten at the end of the task. Given the emphasis of the authentic task within TBLT, we have used the kitchen environment as a learning context since the act of cooking a meal is an authentic task with a clear goal and end product. The notion of cooking as pedagogy or experiential learning has been specifically explored by cultural anthropological approaches as an activity involving "multisensory experiential learning" (Trubek & Belliveau, 2009, p.16). The kitchen is seen to: "engage students at an almost instinctive level; the smells, sounds, sights, textures and tastes excite senses and intellects" (2009, p.16).

DESIGNING THE FRENCH DIGITAL KITCHEN

In this section we firstly describe the project background, then how the French Digital Kitchen works in practical terms. We then move on to describe the design principles on which it is based in terms of TBLT, Human-Computer Interaction and User-Centred Design.

Project Background

The French Digital Kitchen project was the result of collaboration between computer scientists working on the development of assistive technology for pervasive environments, namely the construction of an Ambient Kitchen used to support people with dementia (Olivier, Guanyou, Monk & Hoey, 2009; Pham & Olivier, 2009) and applied linguists working on how digital technology can be combined with a task-based approach to language learning (Seedhouse & Almutairi, 2009). Our project involved taking a normal kitchen and adapting it for French language learning using activity recognition and digital sensor technology. We constructed a purpose-built kitchen (see Figure 1) that communicates with learners in French and gives them step-by-step instructions on how to prepare French cuisine and learn aspects of French language, developing two sets of skills simultaneously. We chose cooking as a relevant task as there is currently huge interest throughout the EU in cooking, as can be seen in the number of cookbooks sold and the number of cooking programmes on TV. Many adult learners are motivated to learn European languages through their interest in cuisine and culture, and this project taps into this motivation.

How Does the French Digital Kitchen Work?

Constructing the French Digital Kitchen involved drawing on an existing technologically-enhanced kitchen (the Ambient Kitchen) which was originally developed to support older people and those with dementia in their everyday kitchen activities. The term 'ambient' refers to the nature of the technology used in the kitchen, which is absorbed or hidden in that environment and, similarly to a car satellite navigation system, is designed to guide and support the user in an everyday setting. The Ambient Kitchen was designed to provide situated support in the form of written or audio prompting during a kitchen-based activity such as making a cup of tea. It does this by detecting actions and linking these to the possible intentions of the user.

In the French Digital Kitchen, this technology was developed so that the kitchen speaks to the learners in French, providing step-by-step cooking instructions in relation to learners' completion of the cooking steps. It can also

Figure 1. Purpose-built French digital kitchen

detect what the learners are (or are not) doing and this information is used by the kitchen programme to provide feedback, such as a reminder, or to provide more details about a certain cooking action in French, or to know when to move to the next question. Embedded or hidden digital sensors were developed and inserted in or attached to all the equipment (for example, a peeler, a mixing bowl, a whisk or even the oven door) and ingredients (for example, a bag of flour, sugar or a tub of butter) as in Figure 3. The sensors use a technology similar to the Nintendo Wii™. The sensors hidden in the knife, for example, were designed to detect whether a 'chopping' action' or a 'scraping' motion is being made and provide appropriate feedback. Learners are also able to communicate with the kitchen, using an interactive screen or Graphical User-Interface (GUI), where they can request audio and textual help along the way in the form of repetitions, translations and the ability to move back and forward between the cooking instructions, as in Figure 2.

Following standard TBLT practice, kitchen users work in pairs; we normally paired users with skills in French together with users with skills in cookery so that they were able to exchange skills. Users followed the 3-stage task cycle detailed in the previous sections.

The *pre-task* involved a dual focus on cooking and French skills and was divided into presentation and preparation of French and

Figure 2. Interactive screen or graphical user-interface (GUI)

Figure 3. Sensors embedded in utensils and attached to ingredients

cooking. First, learners could watch a purpose-made video recording with optional sub-titles of a native-French speaker making the chosen dish for the project, *Clafoutis aux poires*. This familiarised them with both the cooking procedures required and with the French language to be employed. They were able to choose to watch without sub-titles, with French sub-titles or with English sub-titles, depending on the level of support they required. Next, the learners were able to watch an audio-visual slide-show of the different utensils and ingredients they would need to make the dish, in order to familiarise them with the specific vocabulary required for the task. Figure 4 shows how each slide contained a photo of the kitchen utensil or ingredient, the corresponding word written in French and the option to listen to an audio file of the word being spoken. These first two activities were displayed on specially designed 'ambient' display screens on the walls of the kitchen (see Figure 1). The final stage of the preparation involved listening to the kitchen, which verbally communicated the ingredients and quantities required via the speakers. At this stage in the task, the learners also had the opportunity to use the interactive screen to request help such as a translation in English or the repetition of a phrase.

The *during-task* phase involved step-by-step instructions on how to prepare the dish, together with a range of relevant feedback. The instructions and the feedback were communicated by the kitchen as and when required according to the learners' actions. The cooking task instructions were formulated in such a way as to include cooking-specific vocabulary on which we expected learners would focus most of their attention. Some examples of these instructions are shown in Figure 5 and cooking-specific vocabulary is highlighted in bold.

Feedback included creating alternative versions of instructions, often reformulated in terms of 'tips' about cooking technique, which acted as prompts; Figure 6 shows a sample of these. English translations were also created using cooking specific vocabulary. The final design of the cooking task instructions and feedback came about after a series of pre-trialling of different task instructions.

The *post-task* focused on evaluation of what the users had learnt. Targeted vocabulary was re-introduced to the learners through a series of short exercises. The exercises were designed to be completed orally and presented on the 'ambient' display screens in the kitchen. So whilst the focus *during-task* was on meaning and task completion, the focus *post-task* was mainly on linguistic form and on which language items learners had acquired through the task. An example of one of these exercises is given in Figure 7 and Figure 8 shows a learner carrying out the activity.

Figure 4. Example of slide in audio-visual vocabulary slideshow

Figure 5. Examples of cooking instructions with specific cooking terms

Épluchez, dénoyautez *et* ***coupez*** *les* ***poires*** *en quartiers et en tranches*

(Peel, core and cut the pears in quarters and in slices)

Figure 6. Examples of prompts for the learners

Il vous faut un peu de farine

(You need a little flour)

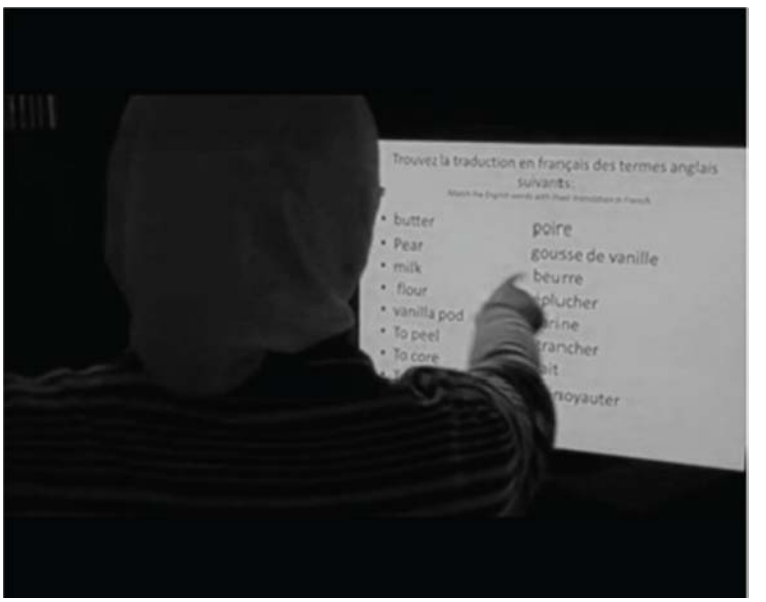
Figure 7. Example exercise from the post-task

Trouvez la traduction en français des termes anglais suivants:

Match the English words with their translation in French

• butter	poire
• Pear	gousse de vanille
• milk	beurre
• flour	éplucher
• vanilla pod	farine
• To peel	trancher
• To core	lait
• To slice	dénoyauter

Figure 8. A French learner carrying out one of the post-task exercises



DESIGN PRINCIPLES

In the previous section, we described the practical functioning of the kitchen. In this section, we explain our design methodology for constructing and trialling the kitchen, which draws on TBLT and Human-Computer Interaction (HCI), including User-Centred Design (UCD).

Human-Computer Interaction Design Principles

HCI employs 'bottom-up' approaches, where development of the technology is based on direct observation and investigation of usability of an initial prototype. As Abras et al. state, "the role of the designer is to facilitate the task for the user and to make sure that the user is able to make use of the product as intended and with a minimum effort to learn how to use it" (2004, p. 763). To do this, HCI designers go through a range of iterative processes to produce a design which is based on user activity. In the French Digital Kitchen, HCI design focused on 'ambient displays' on the kitchen walls (Figure 1) and the provision of a Graphical User-Interface (GUI) (Figure 2), as well as an in-built hidden speaker system. How did the HCI design support the TBLT framework? The 'ambient displays' provided a location from which to show the recipe preparation video and the vocabulary slideshow, and the in-built speakers streamed the audio information attached to this visual information. The speaker system also provided the list of ingredients in the *pre-task*. The GUI was specifically designed to support learning processes. In the *pre-task*, the GUI offered three types of scaffolding: translation request, repetition request and the option of moving back and forwards through the list of ingredients. In the *during-task* phase, the GUI provided learners with translations, repetitions and the option to move around the cooking instructions. In classroom-based TBLT, the learners carry out tasks themselves, but can call on the teacher as a resource if they require some kind of help or support. In a similar way, the GUI provides scaffolding for learners if and when they require it.

Learning was also supported through the activity recognition sensor technology, which was designed to provide the different steps of the cooking instructions in a timely manner, that is, as and when learners were ready in terms of how they were progressing through the recipe operations. Further scaffolding was provided in terms of prompts, consisting of alternative versions of instructions, often reformulated in terms of 'tips' about cooking technique. The prompts were designed in such a way as to occur in response to two alternatives: a) after a period of non-activity where the sensor technology was able to detect that an operation had not been carried out even though a cooking instruction had been communicated or b) if the incorrect food item or kitchen equipment had been moved as a result of miscomprehension. A final part of the physical design of the kitchen was the inclusion of labelling in French on all items associated with the cooking task (tub of flour, oven door etc.) as well as the kitchen itself (cupboards, chopping board, tap etc.). Similarly to the technological affordances for the *pre-task*, the *post-task* exercises were also embedded in the kitchen using the 'ambient displays' (Figure 8).

User Centred Design Principles

The principles of User-Centred Design (UCD) (Norman & Draper, 1986; Norman, 1988) informed the kitchen design, meaning that the user was being placed at the centre of the design process in terms of their interaction with the technology. Abras et al. (2004, p. 768) characterise UCD as "a philosophy and methods which focus on designing for and involving users in the design of computerised systems". Users should be involved "during requirements gathering and usability testing" (ibid, p. 763). In terms of an instructional setting, UCD can be linked to the theoretical notion of situated action (Suchman, 1987, p. 179), involving the explication "of the relationship between structures of action and the resources and constraints afforded by physical and social circumstances". UCD is specifically focused, therefore, on the contextualised 'in the

moment' behaviour rather than pre-determined generalisations of potential behaviour. Four of Norman's (1988) proposals underlie the design of the kitchen. First, a UCD should "make it easy to determine what actions are possible at any moment" (1988, p. 188). The GUI screen offers a resource through which scaffolding can be provided by selecting different options at any particular moment. The provision of timely feedback in the form of prompts and the occurrence of cooking instructions, as and when they are needed, is intended to make clear to users what is possible at any given moment within the cooking task. A second suggestion, "make things visible" is afforded in the ways that the GUI is visually designed to easily locate the alternative levels of linguistic input available. Thirdly, the principle that a UCD should "simplify the structure of tasks" to make sure that "the user has control over the task" is incorporated in both the design of the GUI and the way that instructions and feedback are provided through activity recognition (p.188). Finally, the notion that UCD should "design for error" is integrated into the possibility for the user to move back and forward between the different stages of the task in terms of the linguistic input provided. The next step in this process was to make users a central part of the developmental process of the kitchen through trialling and further processes of formative evaluation.

RESEARCHING LEARNER USE OF THE KITCHEN

Aims and Research Questions

As indicated above, a vital element of HCI development is iteration based on observation of user or learner activity. In this section, we describe the research element of the project, which had a dual function. Firstly, it provided data to enable modification of system design. Secondly, it provided answers to the research questions. The overall aim of the project was to produce a technologically-enhanced situated language learning environment where learners could simultaneously learn a linguistic and a non-linguistic skill.

How can situated language learning be supported by digital technology? The main question was answered by the construction and trialling of a digital kitchen for learning French language and cuisine, which uncovered the technical challenges involved in re-purposing context-aware environments for situated learning applications. Sub-questions were:

To what extent do participants acquire two sets of skills simultaneously? This question was answered by means of two sub-questions:

- *Which aspects of French language are acquired by users of the kitchen?* This question was answered by analysing sensor and display data, video and audio data with their transcripts, and post-test data. We combined task-tracking hardware and software, video/audio recording and transcription to relate non-verbal communication and performance of the task to the details of the talk. The task aimed to teach specific vocabulary; a post-test of targeted vocabulary was provided via the digital display. There was also an audio-recorded post-task self-report and a written questionnaire in relation to what they had learnt. To determine whether users had learnt a specific lexical item, we were able to combine evidence from the interaction (see extracts in the Appendix) with post-test data and self-report data.
- *Are users of the digital kitchen able to follow instructions and successfully cook the envisaged meals?* This question was answered by logging sensor data, using video and audio data, and tasting of products!

Research Instruments and Methodology

Our main source of data was observational; audio and video recordings of the cooking tasks in the pre-, during- and post-task phases

allowed for detailed observation of the pairs as they worked through the task step by step. Each learner wore a radio microphone, whilst two cameras were positioned to capture as much of the physical movement of the learners as possible. These data were analysed using Conversation Analysis (CA), a multi-disciplinary methodology for the analysis of naturally-occurring spoken interaction which is now applied in a very wide range of professional and academic areas. According to Seedhouse (2004), one way of presenting the principles of CA is in relation to the questions which it asks. The essential question which we must ask at all stages of CA analysis of data is "Why that, in that way, right now?" This encapsulates the perspective of interaction as action (why that) which is expressed by means of linguistic forms (in that way) in a developing sequence (right now). In other words, CA is a holistic methodology and is therefore suitable for the analysis of task-based interaction as part of a holistic approach to a learning environment. It has previously been applied to task-based interaction in a digital technology setting in Seedhouse & Almutairi (2009). The aims of analysing the interaction between kitchen users were twofold. Firstly, to uncover the evidence of learning manifest in the details of the interaction, as illustrated in the upcoming section. A full discussion of how CA can contribute to the analysis of language learning in interaction is provided in Seedhouse et al. (2010). Secondly, as part of the process of iterative deployment, evaluation and re-design, we manipulated variables such as timing, exact nature of linguistic input of instructional prompting, location of sensors and pairings of users; we then identified the consequences for the interaction. By analysing the micro-detail of the interaction, we were able to uncover the consequences of design decisions in terms of learning, action and interaction.

In addition to observational data, we gathered sensor and display data using task-tracking hardware and software. The task aimed to teach specific vocabulary and a post-test of targeted vocabulary was provided via the digital display. There was also an audio-recorded post-task self-report and a written questionnaire. Learners were asked what exactly they had learnt and were able to evaluate the experience. The questionnaire included sections on preferences for use of supports (translations, repeats, partners, labels) and difficulties in using audio-instructions to complete the task; this fed into improvements in design. This triangulated approach allowed us to gather evidence from multiple sources for learning of specific items, as is shown in the data analysis below. For example, we were able to show that the participants had learnt specific vocabulary items (e.g. *éplucher*) by checking the interaction, post-test and questionnaire.

Information on Data Gathering

The data sessions (lasting about one hour) involved different pairings based on learners' level of ability in French and cooking skills. We tried to pair participants so that one had a higher level of French and the other was better at cooking. This then created an information gap and potential for information transfer, following TBLT principles. In the trials we documented how the learners behaved when working independently, the different kinds of learning supports they used (for example, the translation facility, labelling), how they interacted with their partners to complete the task, what they learnt and how they learnt it.

A total of 36 audio and video-recorded sessions of paired learners (totalling 72 learners) cooking in the kitchen were collected over a period of two months in the kitchen. The learners (all adults) ranged from advanced French learners to absolute beginners. Table 1 shows the range of learner who took part in the trials in terms of their level of ability in French. 29 sessions took place in the University, whereas 7 took place at a local college where catering students were paired with learners of French. It was central to the project design that a range of ability levels had the opportunity to cook in the kitchen. All participants were adults; many of these were British undergraduates studying French and a range of other subjects, while some were college students of catering.

Table 1. Range of learner levels in the cooking sessions

Pairs	Beginner + Beginner	Beginner + Intermediate	Beginner + Advanced	Intermediate + Intermediate	Intermediate + Advanced	Advanced + Advanced	Native-speaker + Beginner
Number of Sessions	11	4	13	3	1	3	1

FINDINGS: ILLUSTRATION OF THE TASK CYCLE: PRE-TASK, DURING-TASK AND POST-TASK

Given the large amount of interactional data and the limitations of space, we have chosen not to present all of the data. Rather, we illustrate what happens in the digital kitchen by presenting representative episodes from a complete task cycle. The video and audio data and transcripts from this task cycle can be found on http://digitalinstitute.ncl.ac.uk/ilablearn/kitchen. We believe that this approach will best elucidate how the principles of TBLT, HCI and UCD are implemented in this real-world setting, and bring to life the experience of participants using the kitchen. Furthermore, the presentation illustrates how we have applied the CA methodology to the data, how the 3-stage task structure is implemented in practice, and how the data have been used to answer the research questions.

Pre-Task

The role of the pre-task in the overall cooking session is to prepare the users for the cooking activity. Its pedagogical aim is to provide input about cooking and language through the notions of *preparation* and *presentation*. In TBLT, these introduce learners to the linguistic and procedural knowledge required to complete the task. In the French digital kitchen we re-specify the notions of presentation and preparation to a dual focus on language and cooking. Extract 1 (see the Appendix) demonstrates the pre-task in action at the ingredient listing stage.

The extract begins with an audio message from the kitchen that the users are to be provided with the ingredient list to prepare the flan. The orientations of the users to the two opening messages from the kitchen at this early stage exemplify how the pre-task encourages the activation and initiation of existing and new language knowledge. In line 5, S1 self-initiates repair which is hearably addressed to S2, who repairs S1's trouble by providing a translation of the message. In line 7, S1 confirms that the trouble is resolved. In line 9, the kitchen asks them to get a pen and paper to write the ingredients down. This time S1 identifies a target-language item 'un stylo' and in line 13 displays a specific orientation to the state of her L2 knowledge.

In line 15, the listing activity begins in earnest with the first type and amount of ingredient as one hundred grams of flour. A series of paired turns then follows (lines 15-23) where, throughout the listing of ingredients, S2 demonstrates an orientation to their own existing knowledge whilst at the same time providing substitute translations in English for S1. This process can be seen as a collaborative task where S2 provides S1 with opportunities for the activation of new language knowledge whilst at the same time displaying a dual orientation to cooking preparation and existing language knowledge. Throughout the pre-task, the collaborative activation and initiation of existing and new language knowledge is supported by the affordances of the technological design and real-world context of the kitchen. The users are supported interactionally through the process of

cooking preparation: after each item is presented as an audio message, the interactional space is offered for a user-initiated language focus on the on-going activity.

During-Task

The during-task phase of the cooking session, where users are engaged in cooking, promotes the activation and initiation of existing and new L2 knowledge by offering ways for users to notice and use the L2 to complete the cooking task. See Extract 2 in Appendix One for illustration of the during-task phase.

Extract 2 demonstrates how the pedagogical and technical design supports the autonomous learning processes engaged in by the users. The episode begins half way through the cooking task with the audio-message from the kitchen, '*éplucher les poires*' ('peel the pears'). There follows an extended sequence of talk where a trouble source is identified by S2, namely that S2 does not know '*éplucher*' (line 472). The focus on trouble is momentarily suspended whilst the pair returns to a collaborative focus on cooking activity only, where they are performing a check about the amount of pears required (lines 475-478).

In line 480, S2 re-initiates repair of the existing trouble source and in doing so, makes relevant the centrality of the linguistic focus to the task. Line 480 is particularly interesting from a human-computer interaction perspective as S2 directly addresses the kitchen as if it were an interactant. In line 483, S1 displays a further orientation to the technological context of the setting: S2 is trying to work out how to make the kitchen repeat the previous utterance. In line 484, an automated reminder is initiated. This feature is designed to support the users if the intended activity has not been detected after a certain time. In this case, the system supplied the repetition the users were looking for. However, in line 485, we see that the users still do not know the verb.

In line 487, S2 draws on one of the user-controlled supports available in the kitchen to get a translation of the last audio-message, which is able to repair the trouble. In line 489, S2 confirms that the trouble has been resolved. It is now possible for the users to progress with the cooking activity as they know what action is required.

The real-world nature of the task means that the users need to access the right equipment to carry out the right actions for the task; it is not just a question of understanding the input provided in the audio messages. From line 492, we can see how, in this task-based learning environment, knowledge of language and cooking is interdependent. S1 demonstrates an additional orientation to the meeting of new language knowledge concerning the verb '*éplucher*' (to peel). This sequence shows how S1 has both confirmed the learning of '*éplucher*' and is additionally able to apply it to a new (but related) linguistic context. S1 applies the recently noticed verb '*éplucher*' to identify the adjective '*épluchеur*' in the noun phrase '*couteau épluchеur*' (peeler, or directly translated, peeling knife). S1 does this by using a tangible support provided by the kitchen, namely the labelling of utensils and ingredients in the target language. S1's turn demonstrates a dual focus on the on-going cooking action, where a peeler is now needed, and a self-initiated focus on language. S2 shows affiliation in lines 500 to 501, addressing the language focus whilst also performing the relevant next physical action to use the peeler. In lines 502 and 504, S1's turn extends the sequence to explicitly engage with the linguistic structure of the noun phrase, orienting to a focus on form as well as meaning. S1's turn, "what does that mean?" is not actually referring to the meaning of the word '*couteau épluchеur*' but a request for a direct translation of the noun phrase (peeling knife), as becomes clear in line 504.

Extract 2 shows how the pedagogical and technological design allows for the initiation and application of new language which can be made potentially relevant at any point in the during-task phase. This design can support a number of learner requirements which arise during the task. Here, the users draw on a number of affordances, namely the GUI for translation,

sensor recognition-generated messages from the kitchen, objects in the physical context, labels on the utensils and each other.

Post-Task

The pedagogical aim of the post-task focuses on assessment of and reflection about language. Assessment of language knowledge in the post-task is arranged through the identification of language items by the users. See Extract 3 in the Appendix for illustration of the post-task phase.

In this episode, the same users as in Extract 1 are involved. The researcher is pointing them to a slide displayed on the GUI in the digital kitchen which involves matching target language items from the cooking activity with English translations (see Figure 8). S1 identifies '*gousse de vanille*' (vanilla pod') as an item learnt and S2 reciprocates enthusiastically. This can be traced back to the pair's first meeting with this item in the pre-task. In lines 9 to 16, S2 matches target language items with their English equivalents. The reflective nature of the activity is demonstrated through S1's initiation of new knowledge which is oriented to more specifically as a relevant activity for S2. As the episode progresses, the correct matching of language items by S2 also demonstrates consolidated knowledge from the cooking task. The data provided in the post-task were combined with interactional data in pre-task and during-task to provide evidence for learning of specific language items.

DISCUSSION

We now provide answers to the research questions in the light of both the above analysis and the totality of the data. The main research question was: *how can situated language learning be supported by digital technology?* This was answered by the construction and trialling of the French Digital Kitchen; videos of learners using the kitchen can be found on http://digitalinstitute.ncl.ac.uk/ilablearn/kitchen.

To what extent can participants acquire two sets of skills simultaneously by using the digital kitchen? It was evident from observational, post-test and questionnaire data that all participants were able to acquire some elements of the two skill sets at the same time, although of course the amount of acquisition varied greatly.

Are users of the digital kitchen able to follow instructions and successfully cook the envisaged meals? Observational data showed that all kitchen users were able to follow instructions sufficiently well to produce a baked clafouti, although tasting data revealed that products varied in quality!

Which aspects of the French language are acquired by users of the digital kitchen? In the post-task questionnaire, all users reported having learnt some aspect of French and this overwhelmingly focused on vocabulary employed during the task. This was confirmed by the post-tests and observational data. Figure 9 presents a summary of learning processes we observed in our trial data. We gathered data to answer these questions by analysing sensor and display data, video and audio data and transcripts of audio data, together with a vocabulary post-test, and an interview and questionnaire in relation to learning.

FUTURE DEVELOPMENTS

The study has demonstrated how pedagogical approaches (TBLT) and technological approaches (HCI and UCD) can be combined with a research methodology (CA) to provide a means for the iterative development of a language learning environment. The research team have recently been awarded funding from the European Union for a 3 year project to develop the kitchen concept and to build 'portable kitchens'. We will be working with partners across Europe to produce a network of 7 functioning portable kitchens each of which will be able to teach 7 languages and cuisines namely: Catalan, English, Spanish, Italian, Finnish, German and French. This project will enable us to pursue

Figure 9. Summary of the learning processes

Learners **noticed** key words and phrases by:

- **Listening** to the instructions provided by the French kitchen
- **Using** the resources for learning (e.g. labelling of equipment and ingredients in French)
- **Listening** to the appropriate or 'timely' feedback from the kitchen in the form of reminders and reformulations
- **Hearing** their partner use words or phrase in their own creative use of French
- **Using** the translation or repetition facility on the interactive screen

Learners then **manipulated** these key words and phrases whilst talking with their partner, this involved:

- **Reusing** key words during a cooking action
- **Creating** new phrases from key words during a cooking action
- **Creating** new phrases from existing knowledge to communicate personal meanings about a cooking activity and food.

Learners also **demonstrated existing knowledge** of French including key words and phrases, this involved:

- **Using** language to communicate personal meanings about food or a cooking activity
- **Repeating** words and phrases communicated by the kitchen
- **Helping their partner** to understand words and phrases by offering feedback on meaning, pronunciation

iterative development of the learning environment. Our observations of learners engaged in the cooking task suggested some areas of development. A first area concerns differentiation for learners of different ability levels. Observational and questionnaire data from our trials suggest that the interactive screen (GUI) translation facility may limit the application of linguistic knowledge, strategies and use of the target language for some learners. Lower level learners often overuse the translation facility, which appeared to offer an 'easy way out'. We are therefore introducing on-screen visual support in the form of video clips in relation to the actions beginners are asked to perform. Replacing the audio prompts with audio-visual prompts might be better suited to the kitchen as a learning environment. The addition of these audio-visual supports can be viewed as multimedia glosses to facilitate language learning in terms of comprehension and retention, and can cater to learners' preferences (Mohsen & Balakumar, 2011). As such, they would provide "different modalities (textual, visual and auditory) and modes (video, picture and text)" (ibid, p. 136). More work needs to be done on catering for learners at different proficiency levels; at present learners self-select how much support they require from the system. Another area for development concerns the pairing of learners. It was observed that some pairings may have limited learning opportunities. When some advanced and beginner level learners worked together, the advanced learners merely translated instructions for their partner. This meant that the tasks were completed with very little application of language skills or strategy use.

Further information on the project can be found on http://digitalinstitute.ncl.ac.uk/ilablearn/kitchen.

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APPENDIX

Interactional Transcripts

Extract 1

- **AR:** Recorded Instruction
- **S1:** Student 1 (beginner L2 level)
- **S2:** Student 2 (advanced L2 level)

Transcript 1.

1	AR:	pour préparer votre clafouti (.) vous aurez besoin des
2		ingrédients suivants
3		(S2 picks up a pen and prepares to write)
4		(2.2)
5	S1:	what's that mean?
6	S2:	you need the following ingredients
7	S1:	right (.) ok
8		(3.8)
9	AR:	prenez un stylo et une feuille de papier [pour noter les ingrédients
10	S1:	[is that [a pen? HA HA HE
11	S2:	[a pen HA HA HE
12		(1.8)
13	S1:	I understand the odd word
14		(3.8)
15	AR:	cent grammes de farine=
16		(S2 writes down the ingredient)
17	S2:	=a hundred grams of flour (.)
18	S1:	ok
19		(3.2)
20	S1:	should we write –
21	AR:	trente grammes (.) de poudre d'amande (.)
22		(S2 writes down the ingredient)
23	S2:	thirty grams of almond powder

Figure 10. This image relates to line 10 of Transcript 1

Extract 2

- **AR:** Recorded Instruction
- **S1:** Student 1 (beginner L2 level)
- **S2:** Student 2 (advanced L2 level)

Transcript 2.

469	AR:	épluchez les poires
470		(S1 continues with prior task of whisking the batter mix)
471		(3.0)
472	S2:	i don't know what that means
473		(S2 takes the pears out of a container)
474		(3.6)
475	S2:	how many pears? (.) [four]
476	S1:	[four]
477		(3.0)
478	S2:	one (.) two (.) three (.) four
479		(2.2)
480	S2:	right tell me again lady
481		(S2 takes the pears over to the chopping board)
482		(2.9)
483	S2:	how do I make her [tell me]
484	AR:	[n'oubliez pas] d'éplucher les poires
485	S2:	<éplucher les poires> i'm not sure what that means
486		(1.9)
487		(S2 uses GUI to select an English translation)
488	AR:	don't forget to peel [the pears]
489	S2:	[aaaaah] <peel> (.) i swear that could be Eugene that's
490		talking
491		(S2 takes a large knife and goes to peel the pears)
492	S1:	er there's a <le [/kute/] éplucheur> (reading off the label) do you want one of
493		those?
494		(S1 moves towards the peeler on the counter at the side of him whilst holding
495		the whisk over the mixing bowl)
496		(3.7)
497		(S2 puts the large knife on the counter and picks up the peeler)
498	S2:	<épluchеur> (reading off the label on the peeler)
499		(2.9)
500	S2:	very helpful
501		(S2 peels a pear using the peeler)
502	S1:	what does that mean? [a knife to-]
503	S2:	[it's a peeler]
504	S1:	a knife to peel? [is that what it literally means?
505	S2:	[yeah yeah
506		(S1 continues to whisk the batter mixture)

Figure 11. This image relates to line 500 of Transcript 2

Extract 3

- **AR:** Recorded Instruction
- **R1:** Researcher
- **S1:** Student 1 (beginner L2 level)
- **S2:** Student 2 (advanced L2 level)

Transcript 3.

1	R1:	that one is just about vocabulary see if you can match the
2		English words with the French words mainly the ingredients
3		and a few cooking terms that you may have heard
4	S2:	ok (1.2)
5		have you learnt any words (name)?
6	S1:	une gousse de vanille?
7	S2:	yeah!
8	S1:	yes
9	S2:	we've got butter (.) beurre (.) pear poire (.) milk lait (.)
10		flour farine (.) vanilla pod gousse de vanilla (.) to peel is: (.)
11		éplucher!=
12	R1:	=oui! c'est ça éplucher
13	S2:	to core is dénoyauter dénoyauter
14	R1:	oui dénoyauter c'est ça
15	S2:	dénoyauter ouais and slice is trancher
16	R1:	excellent!

Figure 12. This image relates to line 6 of Transcript 3